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REVIEWS OF RECENT LITERATURE.

PHYSIOLOGY.

Heliotropism. — In this paper Holt and Lee[1] are chiefly concerned with a theoretic discussion of the nature of the responses of organisms to light; but they present, also, in support of their theory, the results of some experiments with Stentor Cœruleus, a species of Lynceus, and some fresh-water planarians. The title of the paper, "The Theory of Phototactic Response," is misleading, since the term "phototactic" is used, not in the ordinary sense, but as including those responses which have been called photopathic. In the present state of our terminology "heliotropic" would be a better term.

Intensity of light and direction of ray have been championed for half a century as the important factors of light as a stimulus: at one moment "direction" has been emphasized, at another "intensity." The present writers maintain that light acts only by its intensity, the direction of the ray being a secondary factor and one, furthermore, of an entirely different nature. Their theoretic discussion centers about the views of two prominent physiologists, Loeb and Verworn; and Verworn's theory is accepted as adequate for the explanation of all responses to light. Loeb is characterized as a believer in the importance of "direction," and Verworn in that of "intensity," but it is observed that their theories are not contradictory. So far as the exposition of these two theories, as given in the text, is concerned one seems just as applicable to the facts in question as the other, the only difference being that Loeb has sometimes used the term "direction" when intensity is evidently the determining factor, thus in appearance giving emphasis to the importance of direction, while Verworn has in all cases expressed himself in terms of intensity.

The facts of response to light, admitted as such by Holt and Lee, are three: (1) orientation in the axis of the ray, (2) positive or negative movement, (3) random movement. In explanation it is assumed that animals which show these three phases of reaction have an optimum intensity in which they are not directed by the light but move at random. Below this is the sub-optimal and above it the supra-optimal. An animal in either the sub- or supra-optimal intensity is oriented by the rays so that symmetrical points of the body are equally stimulated; this is, of course, accomplished by the placing of the longitudinal axis of the organism in the axis of the ray. And whether an animal orients itself with head toward or away from the source of light (*i.e.*, whether it is positively or negatively phototactic) depends upon the physiological condition of the animal and the intensity of the light. By sub-optimal intensities organisms are supposed to be directed toward the light through the expansion of those motion-producing elements which are on the side most strongly stimulated; hence there results from this kind of orientation a positive reaction. The same organism, if in a supra-optimal intensity, will be oriented with head away from the light, because in this case contraction instead of expansion is caused, and the reaction will be negative. The orientation theory has been very clearly stated by both Loeb and Verworn.

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[1] Holt, Edwin B., and Lee, Frederic S. The Theory of Phototactic Response, *Amer. Journ. Physiol.*, vol. vi, pp. 460–481, January, 1901.

Several different kinds of reactions, representatively selected, are explained by the writers by their theory; among them is the case of a positively phototactic animal moving toward the source of light into a less intensely illuminated region. This reaction has been taken heretofore as evidence of the independent influence of "direction" of ray. It is clearly shown in the present paper, however, that such a contention is probably false, for difference in intensity and the angle at which the organism strikes the side of the vessel are sufficient to explain the observed courses taken under such conditions.

That light acts through intensity alone is a conclusion which this paper makes plausible, but it scarcely justifies the unconditioned statement that it *does not* act by the course which the rays take through the organism. Such a reaction as the reversal of response observed by Towle in Cypridopsis and by Yerkes in Daphnia and Cypris is not easily explained by the hypothesis under consideration. The paper is valuable in that it makes clear the importance of intensity and at the same time indicates the danger of confusion in using direction as a causal term, although intensity does in part depend upon it.

R. M. Y.

Notes. — The chief defects of laboratory guides arise from the difficulty of giving sufficient directions to the student without supplying him with information that he should get from laboratory